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NEUSE RIVER SHAD INVESTIGATIONS, 1953

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ABSTRACT

The purpose of the Neuse River shad investigation was to determine total catch, fishing effort, fishing rate, size of run, and spawning escapement for 1953. The total catch in the commercial fishing area was 98,000 shad. The fishing rate in this area was estimated to be 65 percent, and the number of shad available to this fishery was approximately 151,000. Most male shad entered the fishery at 4 years of age, most females at 5 years of age. Less than 3 percent of the run had spawned the previous year. It was estimated that 440 shad used the Goldsboro dam fishway during the 1953 run.

Collection of yearly catch and effort records for a period of years is necessary before studies can proceed to determine factors limiting shad abundance in the Neuse River. It is recommended that the gates on the Goldsboro dam be left open during the period March 15 through July 15 so that shad and other migrating fish may have uninterrupted access to the spawning area above the dam.

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NEUSE RIVER SHAD INVESTIGATIONS, 1953

The fishing industry, through the Atlantic States Marine Fisheries Commission, requested the Federal Government to conduct an investigation to determine the cause for the decline in shad production along the Atlantic coast and to suggest measures for the restoration of the runs. Congress authorized such a study, and the U. S. Fish and Wildlife Service initiated the Atlantic coast shad investigation in 1950.

The American shad Alosa sapidissima (Wilson) is an anadromous fish. The young spend their first summer in their native river and then migrate to the sea. After reaching sexual maturity (3 to 6 years) they return to their native river to spawn. It is during this spawning migration that they are liable to capture by the fishery. Fish that escape the fishery are free to spawn, return to the ocean, and reenter the river the following year.

In 1950 and 1951 the Connecticut, Hudson, and Delaware River shad fisheries were investigated, and during 1952 studies were concentrated on Chesapeake Bay and its tributaries. During 1953 the St. Johns River in Florida and the Neuse River in North Carolina were studied. This report concerns the shad fishery of the Neuse River.

The purpose of the Neuse River investigation was to obtain an estimate of total catch, fishing effort, fishing rate, size of run, and spawning escapement for the 1953 season in order to establish a basis for scientific management of the fishery.

Cooperating with the Fish and Wildlife Service in this study were the North Carolina Division of Commercial Fisheries and the North Carolina Wildlife Resources Commission. Burton A. Lehman and Floyd G. Bryant, both formerly employed by the Service, were in charge of the field studies on this river.

DESCRIPTION OF THE NEUSE RIVER AND ITS SHAD FISHERY

The Neuse River is formed by the confluence of the Eno and Flat Rivers in Durham County, North Carolina. It flows southeasterly from the Piedmont through the coastal plain and empties into the southern part of Pamlico Sound (fig. 1). Although the river basin is approximately 180 miles in length, the river itself, measured from its mouth to the source of its longest arm, is approximately 300 miles long. The principal Neuse River tributaries are Flat River, Eno River, Little River, Contentnea Creek, and Trent River.

The Neuse River is free of obstructions upstream to Goldsboro, where a low-head dam equipped with fishway was built in 1952. During periods of high water, fish moving upstream can swim over the dam, but during periods of low flow the fishway must be used if fish are to gain access to the river above.

The Neuse River shad fishery can conveniently be divided into two sections - the commercial fishery and the inland fishery. Although some of the gears used in both fisheries are similar, they are treated separately because the fishery is administered by two departments. The commercial section is under the jurisdiction of the Division of Commercial Fisheries, North Carolina Department of Conservation and Development, and the inland section is under the jurisdiction of the North Carolina Wildlife Resources Commission. The commercial section extends from Turnagain Bay near the mouth of the river to Pitch Kettle, approximately 20 miles east of Kinston. This section also includes tributaries: South River, Lower Broad Creek, Dawson Creek, Adams Creek, Club-foot Creek, Hancock Creek, Slocum Creek, Goose Creek, Upper Broad Creek, and the Trent River. The inland fishery extends upstream from Pitch Kettle to about midway between Goldsboro and Raleigh, including both the main river and its tributaries, Contentnea Creek and Little River (fig. 1). A few shad are taken as far upstream as Raleigh.

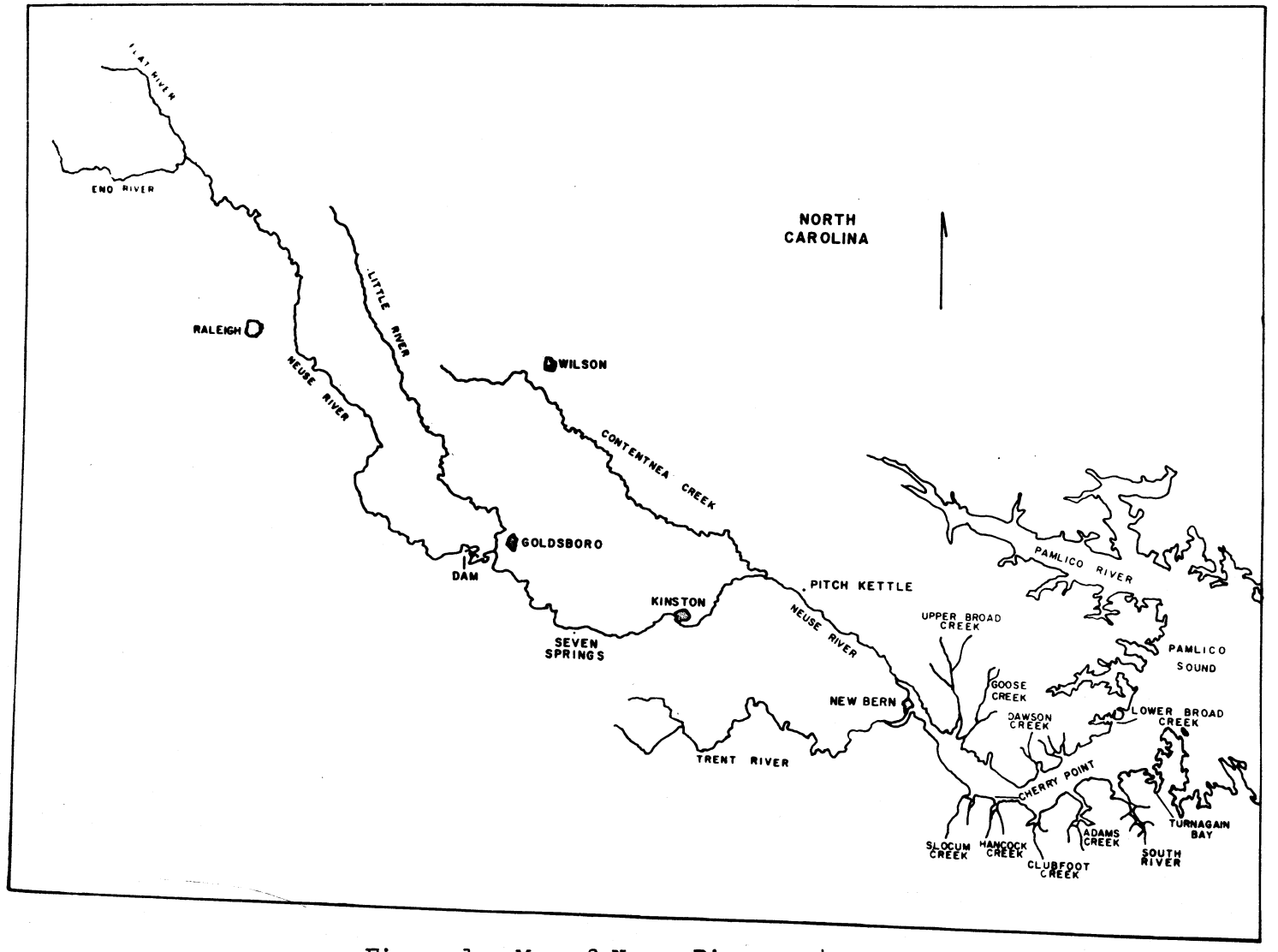

Figure 1.--Map of Neuse River system

Four types of shad-fishing gear are used in the commercial section: stake gill nets, drift gill nets, haul seines, and pound nets. The lengths of stake and drift gill nets range from 10 to 100 yards, and their mesh size from 4 to 5-1/2 inches, stretch measure. Haul seines average 100 yards in length, with a stretch mesh size of 1-1/4 to 2 inches. The pound nets have one head (pocket) with a lead of from 100 to 200 yards. The mesh size of the head is usually 1-1/2 to 2 inches, while that of the lead is 2 to 4 inches stretch measure. The four types of gear are fished in different areas of this section. Pound nets are used in the lower area (between Turnagain Bay and Cherry Point), stake gill nets in the middle area (between Cherry Point and New Bern), and haul seines and drift gill nets in the upper area (between New Bern and Pitch Kettle).

Bow nets, set gill nets, drift gill nets, and haul seines constitute the gears of the inland fishery. Bow net resembles a large landing net with an oval opening 4 to 10 feet in width and 6 to 18 feet in length (fig. 2). These nets are fished either from a stationary platform or from a drifting boat. Set gill nets are similar to the stake gill nets fished in the lower section except that they are tied to trees or anchored instead of being tied to stakes. Bow nets and gill nets are fished throughout the inland area. Haul seines are used in the lower section of this area, mostly in the vicinity of Pitch Kettle. Fish wheels and hog-pen traps are also fished in this sector, but they only take shad incidentally while being fished for other species. The shad catch by these gears is insignificant and will not be considered in this report.

HISTORY OF THE SHAD FISHERY

There are few shad-catch records for previous years on the Neuse River or any other river in North Carolina. Stevenson (1899) and Cobb (1906) give the only shad-catch statistics available for individual North Carolina rivers, and these are for the years 1896 and 1904. Stevenson gives a catch of 181,534 shad for the section of the Neuse River between Adams Creek and Contentnea Creek in 1896, and Cobb gives a catch of 33,738 shad for the same section in 1904. This area approximates the commercial-fishing section of today, from which 98,000 shad were caught in 1953. Since there are no other shad-catch statistics available for the Neuse River, no conclusions could be drawn concerning fluctuations in catch. The total North Carolina shad catch is available for some years, 1880 to 1952 (table 1). Because Neuse River catch records are so meager, the total yearly catch for the entire State is presented to show fluctuations in catch. This catch increased from 3 to 9 million pounds between 1880 and 1897, but after this time decreased, ranging from 2 to 4 million pounds until 1929. From 1929 until 1952 the catch has been close to one million pounds each year.

1953 SHAD CATCH

In the spring of 1953, a program was initiated to obtain catch and effort data from the Neuse River shad fishery. Lists of licensed fishermen were obtained from the North Carolina Division of Commercial Fisheries and the North Carolina Wildlife Resources Commission. Since the number of fishermen was large, it was not possible to contact all of them; hence, for each type of gear, a sample of fishermen from each fishery was selected to keep a daily record of catch and fishing effort.

Unfortunately the number of fishermen sampled in the inland sector was inadequate. It appeared from inspection of the 1952 license lists in the North Carolina Wildlife Resources Commission office that 320 bow nets and 92 gill nets were fished for shad in the counties along that section of the river. The 1953 samples were selected from this 1952 license list. After the close of the 1953 shad-fishing season the current year's license list became available and it was found that 1,183 bow-net and 228 gill-net licenses had been issued in the counties adjacent to the Neuse River. Under the circumstances the data obtained from the inland-sector samples were inadequate and subject to large error, but the results are given as the best estimates available.

Shad-fishing licenses for the commercial section are issued by the Division of Commercial Fisheries, while licenses to fish in the inland section are sold at designated stores in the counties adjacent to the river. After the close of the shad-fishing season each store's license record is sent to the Wildlife Resources Commission office.

Figure 2.--Bow net used for catching shad in the Neuse River (Photo courtesy North Carolina Wildlife Resources Commission).

Table 1.--North Carolina shad catch for selected years, 1880 to 1952 /From U.S. Fish and Wildlife Service, 1953-55, except for 1896, from Stevenson (1899) and 1904 from Cobb (1906)/

Year	Catch in pounds
1880	3,221,000
1887	4,783,000
1888	5,725,000
1889	5,403,000
1890	5,815,000
1896	8,843,000
1897	8,963,000
1902	6,567,000
1904	3,230,000
1908	3,942,000
1918	1,657,000
1923	2,370,000
1927	2,387,000
1928	3,118,000
1929	1,913,000
1930	1,172,000
1931	883,000
1932	925,000
1934	1,274,000
1936	1,095,000
1937	698,000
1938	1,032,000
1939	859,000
1940	801,000
1945	912,000
1950	1,100,000
1951	1,244,500
1952	1,479,200

North Carolina shad-fishing licenses are sold on a county basis with no indication of which river or body of water the licensee fishes. Under the circumstances it is extremely difficult, especially in the inland section of the Neuse River, to determine the total shad catch.

From the sample of fishermen, the total catch (numbers) and effort (net-days) of the commercial and inland sections were estimated. One net-day is defined as a pound net, or 100 yards of gill net, or 100 yards of haul seine fished for 1 day. Catch and effort of each type of gear fished in each sector were determined as follows:

Commercial Section	Pound nets	Gill nets 1/	Haul seines	Total catch
A. Number licensed fishermen	6	186	8	--
B. Number of A in sample	5	59	3	--
C. Total catch by B	12,167	23,829	2,909	38,905
D. Estimated total catch by A	15,000	75,000	8,000	98,000
E. Total net-days by B	4,062	16,193	77	--
F. Estimated net-days by A	5,000	45,000	200	--

Inland Section	Bow nets	Gill nets 1/	Haul seines	Total catch
A. Number of licensed fishermen	1,183	228	18	--
B. Number of A in sample	32	9	4	--
C. Total catch by B	1,481	926	302	2,709
D. Estimated total catch by A	55,000	23,000	1,000	79,000
E. Total net-days by B	393	129	(2/)	--
F. Estimated net-days by A	15,000	3,000		--

1/ Includes both drift and stake gill nets.

2/ Number of days fished not available.

The catch data obtained in this study were used to estimate the Neuse River shad catch by week and area (table 2). The shad-fishing season begins in both areas January 1 and closes May 1 in the commercial area and June 1 in the inland area. The season may be lengthened at the discretion of the Commission, as was the case in 1953. The median week of catch for the commercial area was week 8 while the median week of catch for the inland area was week 19. The later fishing season in the inland section appears to be justified on the basis of the large difference in week of median catch. It should be pointed out that large numbers of blue crab (Callinectes sapidus) and menhaden (Brevoortia tyrannus) invaded the lower commercial area the latter part of March and early April, necessitating the removal of most fishing gear.

TAGGING EXPERIMENT

To estimate the total number of shad entering the Neuse River during the 1953 season, 303 shad were tagged from pound nets near the mouth of the river between January 7 and March 31. Shad were tagged with Petersen disk tags attached below the dorsal fin. A scale sample was taken from each fish, and fork-length, weight, sex, and date of tagging were recorded. As the tagged fish moved upriver to the spawning grounds, they were subject to recapture by all types of gear.

Twenty-one tags were returned from areas outside the Neuse River. Assuming that all tagged shad which left the Neuse River were subject to a 50-percent fishing mortality, the estimated number of tagged shad which left the Neuse River and were unavailable to the fishery

Table 2.--Neuse River shad catch in numbers by week and type of gear, 1953

Date	Week	Commercial[1]		Inland[1]	
		Pound net	Gill net	Bow net	Gill net
1/1-1/7	1				
1/8-1/14	2	300	800		
1/15-1/21	3	900	1,500		200
1/22-1/28	4	1,800	4,500		500
1/29-2/4	5	1,700	4,500		500
2/5-2/11	6	2,100	6,700		700
2/12-2/18	7	900[2]	8,300		700
2/19-2/25	8	1,700	11,300[2]		700
2/26-3/4	9	800	6,700	600	700
3/5-3/11	10	1,100	6,700		700
3/12-3/18	11	1,500	6,000	1,700	500
3/19-3/25	12	1,200	4,500	2,200	500
3/26-4/1	13	300	3,000	2,200	700
4/2-4/8	14	600	3,000	2,800	700
4/9-4/15	15	300	3,000	3,300	500
4/16-4/22	16		3,800	2,200	900
4/23-4/29	17		800	3,300	900
4/30-5/6	18			4,400	1,800
5/7-5/13	19			6,100[2]	1,400[2]
5/14-5/20	20			5,500	5,800
5/21-5/27	21			7,700	2,500
5/28-6/3	22			4,400	2,300
6/4-6/10	23			3,900	
6/11-6/17	24			5,000	
Totals		15,000	75,000	55,000	23,000

1/ Weekly haul-seine records were incomplete and are not included in this table.

2/ Week of median catch.

was 42, and 261 tagged fish were available to the Neuse River shad fishery. One hundred and seventy-four tagged shad were recaptured in the river, 170 in the commercial sector and 4 in the inland sector. Because of the large difference in the tag recovery - catch ratio of the two sectors, the tagging data could not be used to estimate the size of the Neuse River shad run. Three possible explanations why so few tags were taken in the inland sector are (1) the commercial section fishing gear was selective for the tagged fish, (2) recaptured tags were not recovered, or (3) a large run of shad entered the river after fishing ceased in the commercial section.

We can determine whether tag selectivity was a factor. If tagged shad were more liable to capture by certain gears than were untagged shad, we should expect a disproportionate tag recovery - catch ratio among the gears fished in the lower fishery. To determine whether this occurred, the following data were subjected to a chi-square test:

Gear	Catch number	Tags recovered
Pound net	15,000	24
Gill net	75,000	139
Haul seine	8,000	7
Total	98,000	170

$X^2 = 4.4$ $P \sim 0.10$

On the basis of this test, tag selectivity was not significant in the commercial section. We have no definite information that recaptured tags were not recovered or that a late run of shad actually occurred.

An estimate of the number of shad available to the commercial section can be made, using the catch and tag recovery data for this area. Of the 261 tagged shad available, 170 were recaptured in this section. Therefore, the fishing rate was 170/261 or 65 percent. The shad catch in this area was 98,000 fish. With a fishing rate of 65 percent the estimated number of shad available to the commercial section was approximately 151,000. Subtracting catch from total number of shad available, it was estimated that 53,000 shad escaped the commercial section. Since the estimated catch in the inland sector was 78,000 shad, it appears that either our estimated inland sector catch was grossly in error or that a late run of shad did enter the Neuse River after the close of fishing in the commercial section.

SCALE STUDY

Scale samples were taken from 742 shad during the course of the study. Scales from 709 specimens were read, and they ranged in age from 3 to 8 years (table 3). Males first enter the commercial catch at 3 years of age, while females usually first enter at 4 years of age. Most male shad enter the fishery at 4 years of age, most females at 5 years of age. Of the males, 71 percent were 4 years of age or younger; only 26 percent of the females were in this group.

Less than 3 percent (20) of the specimens were repeaters (fish that had spawned the previous year). This indicates that the size of the shad run is dependent almost entirely upon 4-, 5-, and 6-year-old fish which have not spawned before. After spawning, all but a small percentage of Neuse River shad die either in the river or after their return to the sea.

GOLDSBORO DAM AND FISHWAY

The Carolina Power and Light Company has recently completed a steam-electric plant adjacent to the Neuse River near Goldsboro. To ensure an ample supply of "cooling water" the Power Company built a low-head dam, complete with fishway, on the Neuse River (fig. 3). The fishway is a pool type with submerged orifices. The dam is 6.67 feet high and during periods of high water (gage height 9.0 feet or more) presents no obstacle to fish migration, but during periods of low flow (gage height less than 9.0 feet) migrating fish must use the fishway. Water levels of 9.0 feet or more are an exception in May and June (table 4) and therefore the majority of migrating shad must use the fishway to gain access to the river above the dam.

To determine the number of shad passed by the fishway, a trap net was attached to the exit during the period May 5 to June 26, 1953, and all fish using the fishway were subsequently

Table 3.--Age of Neuse River shad taken from the commercial catch, 1953

Age	MALES		FEMALES	
	Number	Percent	Number	Percent
3 years	64	15	3	1
4 years	236	56	72	25
5 years	115	28	127	44
6 years	2	--	82	28
7 years	0	--	7	2
8 years	1	--	--	--

Table 4.--Number of days Neuse River, Goldsboro station gage was 9.0 feet or higher.

/Gage readings obtained from U. S. Department of the Interior, Geological Survey, Water Resources Division/

	January	February	March	April	May	June	July
1952	1	15	31	6	3	0	0
1953	21	23	31	12	2	10	0
1954	14	12	19	19	4	0	0

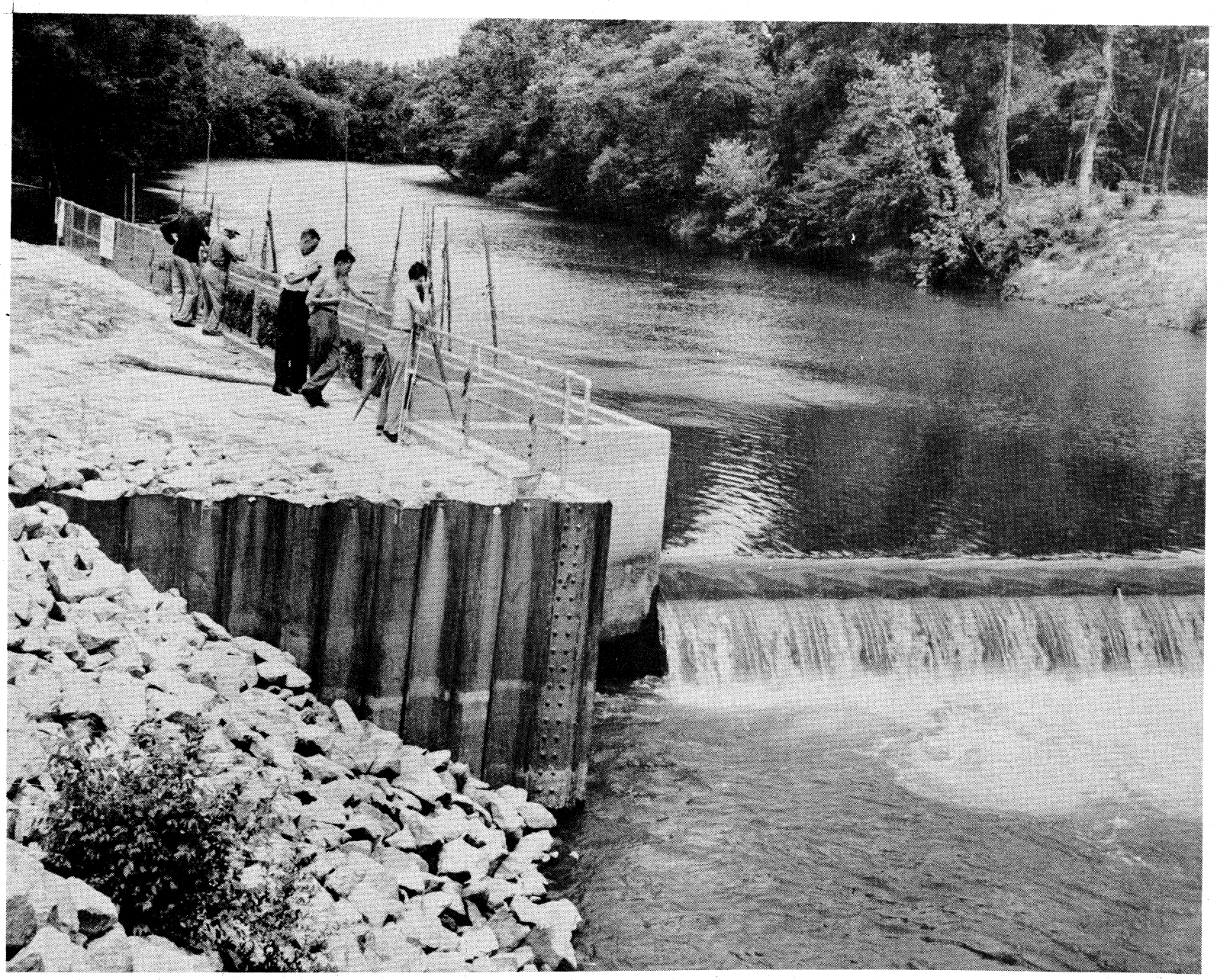

Figure 3.--Carolina Power and Light Company dam and fishway near Goldsboro, N. C. (Photo courtesy North Carolina Wildlife Resources Commission.

caught (table 5). During this period the net was fished for 498 hours[1/] (equally divided between day and night fishing) out of a total of 1,272 hours. Fish had to use the fishway for 984 hours, which was the period of time the water height was below 9.0 feet. The number of shad passed in 498 hours was 224. Therefore, it is estimated that 440 shad used the fishway between May 5 and June 26, 1953. The efficiency of the fishway was not determined because no estimate could be made of the number of fish which desired to pass above the dam.

RECOMMENDATIONS

Accurate catch and effort statistics collected for a period of years are essential before any attempt can be made to scientifically manage a shad fishery. This type of data is lacking for the Neuse River and every other river in North Carolina. Scientific management of the fishery requires that the State of North Carolina establish a system of collecting accurate catch and effort statistics. These data should include both the amount and type of gear fished and the total catch made by this gear each day. After data of this type have been collected for a period of years, studies can proceed to determine what factors are limiting population abundance. If these factors can be controlled, the Neuse River shad fishery could then be managed to obtain an optimum yield.

The Carolina Power and Light Company dam near Goldsboro was constructed to ensure a supply of water during extreme low flows which rarely occur. The dam is equipped with two sluiceways or flood gates which are fitted with stop logs to a height level with the top of the dam. It is proposed that the power company remove the stop logs from the sluiceways during the period March 15 through July 15 so that shad and other species desiring to spawn in the river above the dam may do so. The stop logs could be replaced when low river flows necessitate pondage. Low flows generally occur only in late summer and therefore the sluiceways could remain open during the remainder of the year.

1/ The number of hours the net was fished when gage height was less than 9.0 feet. No fish used fishway at gage heights above 9.0 feet.

SUMMARY

The Neuse River shad fishery was investigated to determine total catch, fishing effort, fishing rate, size of run, and spawning escapement for 1953.

Fishing in the Neuse River is under the jurisdiction of two departments. The commercial fishery, extending from the river mouth to Pitch Kettle, is administered by the North Carolina Department of Conservation and Development, and the inland section, extending from Pitch Kettle to the headwaters of the river, is administered by the North Carolina Wildlife Resources Commission.

Shad are taken in the Neuse with the following types of gear: pound nets, stake gill nets, drift gill nets, haul seines, and bow nets. The fishing season in the commercial area is from January 1 to May 1 and in the inland area from January 1 to June 1. The season can be extended as was done in 1953.

The shad catch in each sector was estimated from the catch of a sample of the fishermen. The estimated catch of the inland sector was subject to large error because of the small sample from which it was derived.

An estimate of the number of shad available to the commercial sector was made. The catch in this sector was 98,000 shad and since the fishing rate was 65 percent, the number of shad was approximately 151,000. Estimated escapement from the commercial sector was less than the catch in the inland sector. Either the inland catch was overestimated, or a late run of shad entered the river after the cessation of fishing in the lower river.

Shad scales from 709 fish taken from the commercial catch were read to determine age. Most male shad enter the fishery at 4 years of age, most female shad at 5 years of age. Less than 3 percent of the run was made up of fish that had spawned the previous year. Most Neuse River shad probably die after spawning or upon return to the sea.

A fishway on the Carolina Power and Light Company dam near Goldsboro permits shad

Table 5.--Fish which used the Goldsboro fishway from May 5 to June 26, 1953

Common name	Scientific name	Number
American shad	Alosa sapidissima	224
Channel catfish	Ictalurus punctatus	131
Carp	Cyprinus carpio	33
Sunfish	Lepomis sp.	20
Longear sunfish	Lepomis megalotis	8
Redhorse	Moxostoma sp.	7
White sucker	Catostomus commersonni	4
Green sunfish	Lepomis cyanellus	3
Brown bullhead	Ameiurus nebulosus	2
Alewife	Pomolobus pseudoharengus	2
Striped bass	Roccus saxatilis	2
Largemouth bass	Micropterus salmoides	1
Crappie	Pomoxis sp.	1
Mullet	Mugil sp.	1

to gain access to the river above the dam during low-water periods. Shad can swim over the dam during periods of high water. It was estimated that approximately 440 shad used the fishway during the period May 5 and June 26, 1953.

Before the Neuse River shad fishery can be scientifically managed, catch and effort data must be gathered for a series of years. Studies can then be undertaken to determine factors limiting population abundance. If these factors can be controlled, it may be possible to manage the Neuse River shad population to obtain maximum yields.

It is proposed that the Carolina Power and Light Company open the sluice gates on the Goldsboro dam during the periods March 15 to July 15, so that shad and other fish may have uninterrupted access to the spawning area above the dam.

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